

**U.S. DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL WEATHER SERVICE  
NATIONAL METEOROLOGICAL CENTER**

**OFFICE NOTE 16**

**HYDROSTATIC AND WIND CHECK IN THE ADP PROGRAM**

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Computation Branch**

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**This is an unreviewed manuscript, primarily intended for informal  
exchange of information among NMC staff members**

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## INTRODUCTION

For radiosonde reports, a hydrostatic check is made to determine whether the given soundings are consistent throughout the reported mandatory levels from 1000 to 200 mbs. Furthermore, whenever winds are included in a report, a vertical consistency check is made on the wind direction and speed at the mandatory levels. The hydrostatic and wind checks as used in the ADP program are only intended to eliminate gross errors. Consequently, the computed values used for checking thickness and wind are only roughly calculated and the accompanying maximum allowable errors are consistent with these rough calculations. A further discussion of each of these checks follows.

### HYDROSTATIC CHECK\*

A computed "D" thickness ( $\Delta D_c$ ) and a maximum allowable error ( $E_{max}$ ) are found for each single layer (e.g., 1000-850, 850-700, etc.) where both the temperatures and the D values are reported at both the top and bottom of the layer. If there is not enough data reported to make the check with a single layer,  $\Delta D_c$  and  $E_{max}$  are computed using values from the top and bottom of double layers such as 850-500 or 700-400.  $D_c$  and  $E_{max}$  are computed in each layer. Whenever the D value for the upper level of a layer differs from  $D_c$  by more than  $E_{max}$ , the layer is tagged in error and  $D_c$  is saved temporarily. A check is then made on the

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\*This section was amended by A. F. Gustafson to clarify the methods of computing  $\Delta D_c$  and  $E_{max}$ .

next level. If an error occurs using the reported data at the lower level, the  $D_c$  replaces the reported data and the correction is noted in the discrepancy listing.

When all reported levels for a given report have been checked,  $D$  values and temperatures are erased at the levels tagged in error and which could not be corrected with the computed  $D_c$ . These levels are noted in error on the discrepancy list.

The computed thickness  $\Delta H_c$  is obtained as the sum of (1) the thickness for a layer whose mean virtual temperature  $\bar{T}_v = 0^\circ\text{C}$  and (2) the rate of change of thickness per degree of change (or difference) in the mean temperature times the "observed" mean temperature which is the same as the difference in temperature from zero degrees. This is expressed symbolically as:

$$\Delta H_c = H_1 + (2d) \bar{T}$$

where  $H_1$  = thickness when  $\bar{T}_v = 0^\circ\text{C}$

$$\bar{T} = 1/2 (T_1 + T_2) \quad (T_1 \text{ and } T_2 \text{ are reported temps at bottom and top of layer.})$$

$$2d = \frac{H_1 - H_2}{50 \times 10} = \text{change of thickness per 1/10th degree of difference in } \bar{T}.$$

$$H_2 = \text{thickness for } \bar{T}_v = -50^\circ\text{C}$$

In practice the "D" thickness,  $\Delta D_c$ , is computed from the relation.

$$(1) \Delta D_C = c + d(T_1 + T_2)$$

where  $c = H_1 - H_5$

$H_5$  = thickness of layer in the standard atmosphere

The maximum allowable error,  $E_{\max}$ , is computed under the assumption that the worst possible deviation from an assumed mean virtual temperature,  $\bar{T} = 1/2 (T_1 + T_2)$  would occur in the case of a dry adiabatic lapse rate from the top of the layer down to a significant point just above the base of the layer. (A sharp inversion back to the temperature at the base is hypothesized.) In this case, the tolerance can be computed as the difference in thickness between a layer with the observed lapse,  $\Delta T = (T_1 - T_2)$  and a layer with a dry adiabatic lapse  $\Delta T_Y = (\Delta Z) \gamma_d$ .

The difference  $\Delta H$  in thicknesses between an isothermal layer ( $\Delta T = 0$ ) with  $\bar{T} = -30^\circ$  and a layer whose upper temperature is  $-30^\circ$ , but which has a dry adiabatic lapse below this, is first computed\*. The mean temperature of this isentropic layer is:

$$\bar{T}' = -30^\circ + 1/2 \Delta T_Y$$

The maximum allowable tolerance would then be:

$$"E"_{\max} = \Delta H \left( 1 - \frac{\Delta T}{\Delta T_Y} \right)$$

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\*Actually  $\Delta T_Y$  is taken as the adiabatic temperature change thru the layer in question beginning from a standard temperature at the lower level.

In practice, however, allowance is made for a virtual temperature correction  $\delta T_v$  and a "padding" constant of six decafeet is also added.

With these additions,  $E_{\max}$  is actually computed by the equation:

$$(2) E_{\max} = a + b\Delta T$$

where

$$a = (H_4 - H_3) + 6 \text{ decafeet}$$

$$b = \frac{-(H_4 - H_3)}{\Delta T_v}$$

$$H_3 = \text{thickness for } \bar{T}_v = -30^\circ \text{C}$$

$$H_4 = \text{thickness for } \bar{T}_v = -30^\circ + \frac{(\Delta T_v + \delta T_v)}{2}$$

Substituting these definitions into (2) gives :

$$E_{\max} = (H_4 - H_3) + 6 - (H_4 - H_3) \frac{\Delta T}{\Delta T_v}$$

or

$$E_{\max} = (H_4 - H_3) \left(1 - \frac{\Delta T}{\Delta T_v}\right) + 6 \text{ decameters.}$$

The constants a, b, c, and d in equations (1) and (2) depend only on the layer being checked. The constants for each mandatory layer and each double layer are stored in the program.

### WIND CHECK

The wind check is a check to see that the vector wind deviation at one level from the vector mean for the level above and below is less than a certain amount. In order to avoid trigonometric operations a tabulated

approximation is made using increments of the wind speed and direction.

All combinations of three consecutive mandatory levels (eg. 1000-850-700; 850-700-500, etc.) are considered. For each combination in which winds for all three levels are reported and not tagged in error, the subscripts 1, 2, and 3 are used for convenience. The average mean velocity ( $\bar{V}$ ) is found by taking the arithmetic mean:  $\bar{V} = (V_1 + V_3)/2$ . Likewise the  $\bar{D}$  equals  $(D_1 - D_3)/2$ .  $\bar{D}$  must be adjusted by  $180^\circ$  whenever  $D_1 - D_3$  exceeds  $180^\circ$  in order to assure  $\bar{D}$  is in the proper direction. Criteria for tagging wind errors at the mid level are as noted below.

1. If  $|\bar{V} - V_2| > 35$  knots, tag error in  $D_2$  and  $V_2$ .
2. If  $V_2 < 15$  knots, no check is made.
3. If  $30 > V_2 > 15$  knots and  $|\bar{D} - D_2| > 60$  degrees; tag error in  $D_2$  and  $V_2$ .
4. If  $V_2 > 30$  knots and  $|\bar{D} - D_2| > 30$  degrees, tag error in  $D_2$  and  $V_2$ .

When all possible levels have been checked, the rules for erasing reported winds are:

1. Erase wind at the level tagged in error, and note level on the discrepancy list.
2. Erase wind at the preceding lower level if it could not be checked. That is, if the preceding lower level is the lowest considered (1000 mb) or if wind at the second lower level is missing.

3. Erase wind at the succeeding higher level if it could not be checked. That is, if the succeeding higher level is the highest considered (200 mb) or if wind at the second higher level is missing.